APPLICATION OF THE DIFFERENT DEVELOPMENT INDEXES IN THE RESEARCH OF SCIENCE DIDACTICS[1]

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Abstract

In the last few decades the analysis of data, obtained from different science and technology education related international surveys, has produced some new viewpoints such as the diversity of cultures, the trends of globalization, different theories such as postmodernism, self-determination. Within those researches different reference factors have been investigated to obtain results, possible to explain different phenomena observed in the society.

In our research some indexes such as Human Development Index (HDI) and Environmental Sustainability Index (ESI) normally used in sociological research have been used with the aim to find correlations with the international ROSE (The Relevance of Science Education) project data. The items in the ROSE questionnaire are measuring students' general interest in science and technology and their interest in different content and contexts of science and technology as well as students' science and technology related experiences. Based on our analysis, there were relatively high correlation between the mean values of different national ROSE variables and responding HDI index.

Key words: *science didactics, indicators, Human development index, Environment sustainability index, Gross domestic product.*

Introduction

Recently a greater significance is being gained by international comparative surveys in all spheres including natural and environmental sciences. Moreover, if initially these surveys concentrated on pupils' knowledge as in, for instance, TIMSS (Third International Mathematics and Science Studies (1995). Trends In Mathematics and Science Studies (2003), OECD PISA

[1] Extended paper, based on materials from conference „Cilveks un vide" [Man and environment], May 2006, Liepaja (Gedrovics, Raipulis, 2007).

(Organization for Economic Co-operation and Development, The Programme for International Student Assessment) in 2000, 2003 and especially 2006, and its 'predecessors', then today results are interpreted also according to cultural differences, as well as to the impact of economic and social factors. A good example here is also the international project ROSE (The Relevance of Science Education (Schreiner & Sjøberg, 2004) aiming to clarify students' general interest in science and technology and their interest in different content and contexts of science and technology as well as students' science and technology related experiences.

When evaluating international comparative surveys, various indexes characterising the development of society have lately been used. For instance, the TIMSS survey reveals that students in countries with low income cannot reach high results (Kangro & Geske, 2001). Another survey conducted within OECD countries, where Latvia was an especially invited participant, indicates that in none of the countries where Gross Domestic Product (GDP) per Capita is lower than 15000 USD students' average achievements reach the average indexes of OECD (Kangro & Geske, 2001).

Along with the above mentioned GDP also Human development index (HDI) is used to compare students' interest in science and technology in various countries. F ex C.Schreiner has used HDI in her doctoral investigation of ROSE data (Schreiner, 2006) as a sign for the degree of modernisation of society and such assumption has allowed her to explain some interesting hypothesis about youth attitude to science and technology including students' interest to study different science and technology topics (Items A, C and E in ROSE Questionnaire, (Schreiner & Sjøberg, 2004)). HDI has been used as indicator by Kristjan K. Stefánsson in his Master Thesis (Stefànsson, 2006) to analyse students attitude to school science and their opinions about science and technology as socially important phenomena, as well as for youths attitude to their future occupation (Items F, G and B resp. in ROSE Questionnaire). But both researchers has been investigated a relatively big group of countries, totally 29 countries.

Moreover, there was analyzed also the applicability of Environmental Sustainability index (ESI) and GDP for these comparisons. Student interest in science and technology in Nordic countries, the Baltic countries, except Lithuania, as well as in the United Kingdom, Russia, Poland and the Czech Republic (totally 11 countries) is measured by the international comparative ROSE survey (Schreiner & Sjøberg, 2004).

The research questions are:

- What kind of correlation there are between ROSE items measuring students' interest in science and technology related themes and national Human Development Index, Environmental Sustainability Index and Gross Domestic Product per Capita index?
- Are there differences in the results among the various development indexes?

Methodology of Research

Background

The ROSE project is a new type of comparative studies. Unlike the already familiar in Latvia TIMSS and OECD PISA this survey, involving 15- year-old students (in the majority of countries they were Form 9 students) from 40 countries, puts the main stress on researching the respondents' *attitude* to science and technology, and analyses the data in the context of cultural diversity. So, in this study, unlike in the above mentioned TIMSS and OECD PISA, students' knowledge of science does not play a decisive role.

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Respondents

The total number of respondents from Latvia and several European countries (Denmark, Iceland, Norway, Finland, Sweden, Estonia, Russia, The Czech Republic, Poland, and The United Kingdom) was 13 180. The ROSE project in Latvia was conducted between March - April 2003 (collecting questionnaires from 39 comprehensive schools). The ROSE Project has been repeated in Latvia (25 schools), Poland (5 schools) and Czech Republic (5 schools) autumn 2007/ early 2008 (in text named as 2008).

Instrumentation

The instrument of this project is a questionnaire with 250 various statements arranged into 10 sections. Three of those (sections A, C and E) are devoted to issues students would like to study in science lessons (108 statements altogether) and the rest, correspondingly, to revealing the respondents' viewpoints on environment, on the role of science in school and society, on the criteria of choosing a career and on students' own experience with science and using technologies. There is also a section where students are asked to describe, in open format, what they would like to investigate, if they became scientists, and why. This publication uses Items A, C and E: *What I want to learn about*? as examples. Besides, the analysis includes also several statements from those sections where respondents have described their willingness to study environment related issues in scientific context and to take part in environment protection (B: *My future job*; D: *Me and the environmental challenges;* F: My science classes; H: *My out-of-school experiences*).

The questionnaire is based on the four-point Likert scale, which in itself is a kind of range scales. Respondents have to provide answers ranging from total denial (*not interested, disagree, never*) to strong affirmative (*very interested, agree, often*). Having coded the students' answers with numbers from 1 to 4 we receive the average mean M where $1 \leq M \leq 4$. Those values reveal the trends in the answers among a particular group of respondents. With average mean $M > 2.5$ we can assume that the majority of respondents agree with respective statement. More information about the project can be obtained from C. Schreiner's Ph.D. Thesis (Schreiner, 2006) as well as from (Schreiner, Sjøberg, 2004) and (Stefánsson, 2006).

Description of Different Development Indexes

The Human Development Index

The Human Development Index is an indicator used by the United Nations experts to determine countries' development (Human Development Report, 2005). Actually this is a complex indicator consisting of three indexes each characterising, correspondingly, achievements in health, education and the standard of living in a particular country (Table 1). The advantage of this index is that it allows ranging countries by their achievements in human development.

It must be noted that in the context of education HDI concerns adult literacy and the total number of students at basic, secondary and university levels. GDP is part of this index as an indicator of living standards, namely – of people's purchasing capacity. However, while allowing comparison of various countries, HDI does not provide a clear answer as to the reasons of changes in this index in a particular country in the course of time.

Table 1. Human Development Index, Environmental Sustainability Index and Gross Domestic Product (per Capita, in purchasing parity, USD).

Country	Human Development Index (HDI)			Gross Domestic Product (GDP)			Environment Sustainability Index (ESI)	
	2001[1]	2003[2]	2007[5]	2002[3]	2003[2]	2007[6]	2002[3]	2005[4]
Czech Republic*	0.868	0.874	0.903	12 891	16 357	18 557	49.7	46.6
Denmark	0.930	0.941	0.955	25 341	31 465	56 115	58.1	58.2
Estonia	0.833	0.853	0.883	8 247	13 539	14 267	59.8	58.2
Finland	0.930	0.941	0,959	22 008	27 619	44 492	73.7	75.1
Iceland	0.942	0.956	0.969	26 626	31 243	37 977	65.7	70.8
Latvia*	0.811	0.836	0.866	6 027	10 270	11 607	62.8	60.4
Norway	0.944	0.963	0.971	27 864	37 670	79 085	72.8	73.4
Poland*	0.841	0.858	0.880	8006	11 379	11 288	46.1	45.0
Russia	0.779	0.795	0.817	6 943	9 230	8 694	48.8	56.1
Sweden	0.941	0.949	0.963	21 483	26 750	43 986	72.2	71.1
United Kingdom	0.930	0.939	0.943	21 270	27 147	35 334	45.2	50.2

[1]*Schreiner, 2006;* [2]*Human Development Report, 2005;* [3]*2002 Environmental Sustainability Index, 2003;* [4]*2005 Environmental Sustainability Index, 2005,* [5] *Human Development Report 2009, List of European countries by GDP (nominal) per capita, 2010.*

HDI is calculated almost for every year, and it is one of most usable indicator as well, although there are some other economical indicators, which has been used to analyse and characterize different countries. One of them is The Economist Intelligence Unit's quality-of-life index (QOLI), calculated firstly 2005, which is based on a unique methodology that links the results of subjective life-satisfaction surveys to the objective determinants of quality of life across countries (The Economist Intelligence Unit's quality-of-life index, 2005). This index, which includes about 9 different factors such as material wellbeing, health, political stability and other, therefore QOLI is more complicated as HDI. On the other hand we calculated, that there is a very high correlation between QOLI and HDI (r = 0, 97), although HDI includes only three important components. This fact, as well as irregularity of QOLI calculation, compel us to incline for HDI as one of our research object.

The Environmental Sustainability Index

The Environmental Sustainability Index (ESI) which characterises a country's progress in ensuring sustainability in environment protection is in itself a complicated and complex indicator consisting of 20 different sub-indicators (Pilot 2006 Environmental Performance Index, 2006). All those are split into 5 groups that characterise: the state of ecosystems, danger to environment, ecological danger to humans, and capability of society and institutions as well as their readiness to take global responsibility (Table 1).

ESI is not calculated and published each year, though. The most recent data available are of year 2002 (2002 Environmental Sustainability Index, 2003) and year 2005 (2005 Environmental Sustainability Index, 2005). Besides, as we can observe from the index can change quite considerably within a couple of years; therefore it should be applied carefully when describing

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environmental problems. A number of researchers have stressed its too broad interpretation (Pilot 2006 Environmental Performance Index, 2006) as one of its drawbacks. Moreover, from time to time, new criteria are added when calculating the index thus causing difficulty to compare ESI of different years (2002 Environmental Sustainability Index, 2003). Both HDI and ESI are non dimensional quantities.

Under last few years due to a shift in focus by the teams developing the ESI, a new index was developed, the Environmental Performance Index (EPI), which uses outcome-oriented indicators, then working as a benchmark index that can be more easily used by policy makers, environmental scientists, advocates and the general public.

The Gross Domestic Product

The Gross Domestic Product per Capita, which, for better comparability, is often expressed in purchasing parity prices (USD), is one of the most widely used indicators of economic development (Table 1). Very often it is used a separate indicator; however, sometimes it is included into the complex indicators, such as HDI. Like as HDI, the GDP has been calculated for almost every year.

Correlation of HDI and ESI. As mentioned above, neither Human Development Index (HDI) nor Environmental Sustainability Index (ESI) is calculated each year; therefore a question arises, which of the HDI values published would be useful. In the paper (Schreiner, 2006) which analyses relationship between students' interests and HDI, values of HDI-2001 have been used even though the interests of Norwegian students were researched in early 2003, the same time as in Latvia and other countries. As can be observed from Table 1, HDI in years 2001 and 2003 differ little, not more than by 3%. Besides, as testified by correlative analysis, the correlation coefficient between HDI values in both years is 0.996 ($\alpha = 0.95$; $p = 0.01$). On the other hand, Table 1 confirms that HDI for year 2007 has increased for all countries analyzed in our investigation.

Environmental Sustainability Index values in years 2002 and 2005 differ little as well. Moreover, the correlation coefficient between ESI-2002 and ESI-2005 in the above mentioned 11 European countries is 0.96 ($\alpha = 0.95$; $p = 0.01$) which expressed correlation, i.e. change in ESI in all those countries has been equal within the 3 years. But comparing HDI and ESI values we cannot observe a very good correlation, so in HDI-2001/ ESI-2002 the correlative coefficient is only 0.44, but in HDI-2003/ ESI-2002 it is 0.46. In both cases the correlation is poorer. Though it is not disturbing as quantities included into each indicator are totally different.

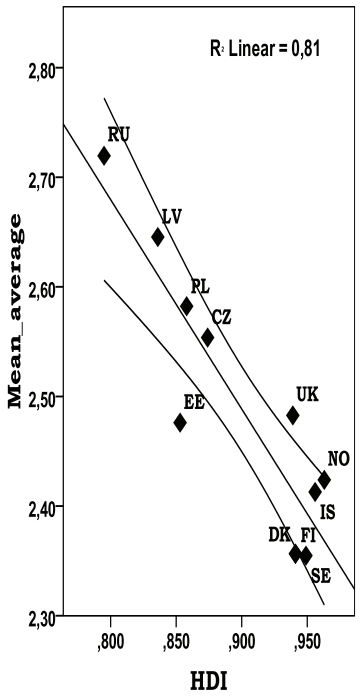
A certain correlation can be observed comparing GDP and HDI values. So comparing GDP-2003 with HDI-2001 and HDI-2003 in both cases the correlative coefficient is the same 0.96 ($\alpha = 0.95$; $p = 0.01$). The correlation is high also between GDP-2002 and HDI-2001 ($r = 0.95$) and HDI-2003 ($r = 0.96$). Obtained correlations let us assume that HDI and GDP could be considered equal indicators.

Data Processing

The data is obtained by inquiring the students. Acquired data was analysed by SPSS program using the methods of statistical analysis (t-test, correlation analysis) of the (version 14.0.).

Results of Research

Taking into account the considerations discussed above, further analysis has been conducted based on the values of Human Development Index and Gross Domestic Product



CZ – Czech Republic,
DK – Denmark,
EE –Estonia,
FI – Finland,
IS – Iceland,
LV – Latvia,
NO – Norway,
PL – Poland,
RU – Russia,
SE – Sweden,
UK –United Kingdom
Mean_average – average mean through Items A, C and E; HDI – Human Development Index

Figure 1. Sample of a dispersion graph for ROSE-2003.

that have been determined in year 2003, as well as Environmental Sustainability Index of 2002 as the ones closest in time to the period of research (1st quarter of year 2003). Using the built in modules of the SPSS program, graphs were drawn (Fig. 1) depicting the dispersion of data together with the regression curve as well as the respective regression equation, like as $y = ax + b$, where x is HDI, ESI or GDP, and y is calculated mean value of respective variable. But coefficients a and b do not are notably informative, unlike R^2, obtained by linear regression analysis: it characterises the quality of regression curve, i.e. to what degree the initial data correspond to the regression model.

On the other hand, R as Pearson correlation coefficient (Table 2) testifies, that there are relatively asset correlation between average mean value ACE (*average mean trough Item A,* Item *C and Item E – What I want to learn about*, resp., *108 items total*) and HDI, as well as GDP. Comparatively high R^2 value (0.81) has been calculated for a great group of other variables, but it must be specified that in the most cases (except variables D06 and H24; see explanation of variables in Appendix) the Pearson correlations are negative both for HDI and GDP as indicator testifies that higher development of respective country, measured by HDI or GDP, produce lower interest to study different science problems and so one. This conclusion conflicts at the first moment with ones obtained by TIMSS – as higher HDI as higher level of knowledge. But we must accentuate the principal difference between ROSE project (evaluation of attitude) and TIMSS (assessment of knowledge). It seems that in countries with higher HDI (and GDP as a component of HDI) it is possible to spend more finances for school development, and growth of knowledge sounds on financial facility but not on more positive attitude.

Table 2. Correlation coefficients for different items from ROSE project' question naire for all 11 countries.

Items	HDI (2003)			ESI (2005)			GDP (2003)		
	R	*p*	R^2	R	*p*	R^2	R	*p*	R^2
ACE	-0.899	0.000	*0.808*	-0.594	0.054	*0.353*	-0.813	0.002	*0.661*
B04	-0.766[b]	0.006	*0.587*	-0.819[b]	0.002	*0.671*	-0.526	0.097	*0.277*
D06	0.567	0.069	*0.321*	0.836[b]	0.001	*0.699*	0.595	0.053	*0.354*
D10	-0.806[b]	0.003	*0.650*	-0.516	0.104	*0.266*	-0.785[b]	0.004	*0.616*
D11	-0.751[b]	0.008	*0.564*	-0.137	0.689	*0.266*	-0.753[b]	0.007	*0.567*
D12	-0.750[b]	0.008	*0.563*	-0.550	0.080	*0.303*	-0.706[a]	0.015	*0.498*
D17	-0.925[b]	0.000	*0.856*	-0.454	0.161	*0.206*	-0.920[b]	0.000	*0.846*
D18	-0.720[a]	0.012	*0.518*	-0.559	0.074	*0.312*	-0.688[a]	0.019	*0.473*
E03	-0.758[b]	0.007	*0.575*	-0.495	0.121	*0.245*	-0.657[a]	0.028	*0.432*
E04	-0.677[a]	0.022	*0.458*	-0.584	0.059	*0.341*	-0.779[b]	0.005	*0.607*
E05	-0.725[a]	0.012	*0.526*	-0.359	0.278	*0.129*	-0.609[a]	0.047	*0.371*
E06	-0.854[b]	0.001	*0.729*	-0.382	0.247	*0.146*	-0.820[b]	0.002	*0.672*
F14	-0.660[a]	0.027	*0.436*	-0.480	0.135	*0.230*	-0.763[b]	0.006	*0.582*
F16	-0.674[a]	0.023	*0.454*	-0.309	0.355	*0.095*	-0.632[a]	0.037	*0.399*
H24	0.691[a]	0.019	*0.477*	0.376	0.255	*0.141*	0.579	0.062	*0.335*

[a] *Correlation is significant at the 0.05 level (2-tailed).* [b] *Correlation is significant at the 0.01 level (2-tailed)*; R – *Pearson correlation; ACE, – average mean through Items A, C and E*

ESI as indicator for analysis within science didactics seems less usable: firstly, the calculated *R* and R^2 values are mainly remarkably lower as one by HDI and/ or GDP and, secondly, ESI is a very complicated indicator, which changes often, although as shown in Table 2, the ESI as indicator correlate quite well with the average mean obtained through questionnaires. But in some other variables the calculated values of R and R^2 are relatively small, about 0.25 resp. 0.3. Therefore it must be pointed that it is not enough to explain ESI as indicator' impact to respective variable. Of course, there was observed that sometimes ESI, on the one hand, and HDI, on the other hand, have opposite effect on R and R^2, f ex by variables D06 (*personall influence on the environment*) and D17 (*Human activity is damaging for the environment*). This observation requests a further research.

Table 3. Several individual results of the ROSE Project, average mean[1], $1 \leq M \leq 4$.

	CZ[2]		**DK**	**EE**	**FI**	**IS**	LV		NO	PL		RU	SE	UK
	2003	2008	2003				2003	2008	2003	2003	2008	2003		
ACE[3]	**2.55**	2.52	2.35	2.48	2.36	2.42	**2.65**	**2.61**	2.43	**2.58**	**2.46**	**2.78**	2.36	2.48
Chemistry	2.33	2.33	2.28	2.29	2.18	2.25	2.45	2.45	2.24	2.40	2.33	**2.53**	2.22	2.33
Biology	**2.66**	2.55	2.46	**2.55**	2.44	**2.51**	**2.71**	**2.63**	**2.51**	**2.71**	2.52	**2.77**	2.45	**2.59**

Physics	**2.59**	2.46	2.35	**2.54**	2.37	2.44	**2.70**	**2.62**	2.48	**2.54**	2.45	**2.78**	2.38	2,48
B04	2.21	2,01	1.84	1.90	2.06	1.87	2.23	2,08	1.78	2.23	2,05	2.18	1.84	1.94
D06	**2.65**	**2,82**	**2.87**	**2.82**	**3.02**	**2.86**	2.31	2,38	**2.98**	2.04	2,47	2.35	**3.16**	2.07
D10	3.58	3,08	2.89	3.50	3.08	3.21	3.28	3,31	3.18	3.47	3,38	3.63	3.13	3.14
D11	2.29	2,37	2.20	2.45	2.33	2.05	**2.74**	**2,70**	2.20	2.32	2,36	2.46	2.27	2.27
D12	3.30	3,16	2.98	3.43	2.94	3.21	3.13	3,15	3.10	3.43	3,12	3.41	2.93	3.01
D17	2.18	2,32	2.09	2.41	2.20	1.87	**2.53**	2,46	1.96	2.43	2,38	**2.53**	2.05	2.13
D18	**2.79**	**2,63**	**2.79**	**2.94**	**2.69**	2.42	**2.78**	**2,77**	**2.70**	**3.14**	2,83	**2.92**	2.50	**2.63**
E03	2.39	2,23	2.32	2.25	2.22	2.33	2.50	2,45	2.28	2.37	2,20	**2.52**	2.24	2.29
E04	2.33	2,24	2.19	2.16	2.22	2.07	2.27	2,34	2.03	2.38	2,16	2.31	2.23	2.18
E05	2.56	2,55	2.62	2.49	**2.55**	**2.52**	**2.77**	**2,70**	**2.58**	**2.77**	2,47	**2.85**	2.44	2.45
E06	2.20	2,28	2.06	2.30	2.22	1.84	2.39	2,34	2.07	2.49	2,16	2.43	1.90	1.94
F14	1.79	1,91	1.56	1.72	1.76	1.80	1.86	1,78	1.56	2.05	1,66	1.88	1.68	1.70
F16	2.06	2,23	1.92	2.18	2.04	2.16	2.07	2,07	1.97	2.14	2,05	2.40	2.12	2.04
H24	**2.67**	2,22	2.07	1.77	2.49	2.11	1.64	1,88	2.42	2.07	**2,86**	1.39	2.50	2.07

[1] average mean M > 2.5 assuming that the majority of respondents agree with the statement, are marked bold

[2] explanations of abbreviations see Fig. 1.

[2] total average mean through items A,C and E

Discussion

As pointed above, the mostly values of Pearson correlation are negative, but in two cases - items D06 (*I can personally influence what happens with the environment*) and H24 *([I have] sorted garbage for recycling or for appropriate disposal*), the correlation is positive, which means - the larger the value of the respective indicator that, in turn, corresponds to a higher human development, the higher the average mean obtained through questionnaires. Moreover, the higher the average mean of a certain variable (statement), the more there are respondents who have answered in the affirmative (*agree*, *very interested, often* opposed to the negative *disagree, not interested, never*) the respective indicator, that, in turn, corresponds to a higher human development, the higher the average mean obtained through questionnaires. However, regarding the statement about sorting garbage (*I have sorted garbage for recycling or for appropriate disposal;* H24) only the majority of Czech students (M = 2.67) have affirmed (Table 3) that they have taken part in such sorting, while students from all other countries, have generally answered in the negative. Though Norwegian, Finnish and Swedish youngsters are close to the average mean (M = 2.50), M respectively: 2.42; 2.49 and 2.50.

Sadly in more economically developed countries students are often not greatly interested in a number of environmental issues that have been mentioned in the ROSE project questionnaire, for instance, those regarding their wish to learn about certain scientific topics in the context of environmental education (E03-E06) as well as those regarding the respondents' attitude to environmental problems (D10 - D12, D17 – D18).

Of course, there are exceptions. For example, in statements D10 (*People should care more about protection of the environment*) and D12 (*I think each of us can make a significant contribution to environmental protection*) the average mean in all eleven countries is above the middle-point (M = 2.50), but in statement D18 (*The natural world is sacred and should be*

left in peace) the majority of mean values is above 2.50. Thus the negative value of correlative coefficient can most probably be explained by the fact that in economically developed countries great attention to environment protection has been paid not just recently but for already a long period. Therefore, perhaps, students from those countries do not perceive this topic so acutely as students from the post-socialistic countries.

Interesting results are provided by item D17 (*Nearly all human activity is damaging for the environment*). Except for Latvia and Russia, in all other countries students have expressed no considerable support to this statement. The majority of respondents have not expressed a wish to learn about such topics as E03 (*The ozone layer and how it may be changed by humans*) and E04 (*The greenhouse efeect and how it may be changed by humans*), as well as about using of technology as a tool for waste', garbage' and sewage' handling (E06). On the other hand the interest is strong in the problems of clean air and clean drinking water (E05; *What can be done to ensure clean air and safe drinking water*).

This brief analysis includes also statement B04 which regards students' future career (*Working in the area of environmental protection*). Again, the more developed the country the smaller is the number of students having participated in the project, who envisage their future jobs connected with environment protection. It must be added here, that though in post-social countries the interest is stronger, the highest average mean is still only 2,23 (in Latvia). Of course, there is the question how many employees would be able to find work in the sphere of environment protection.

To conclude this small insight into individual results of the ROSE project which characterise students' attitude to environmental problems, including environmental education, in the Nordic and several post-socialistic countries, it should be noted that, by applying the indicators meant for describing economic development (Human Development Index, Environmental Sustainability Index, etc.), we can obtain quite interesting material for consideration and further research in order to discover the true motivation behind students' attitude towards natural and environmental sciences.

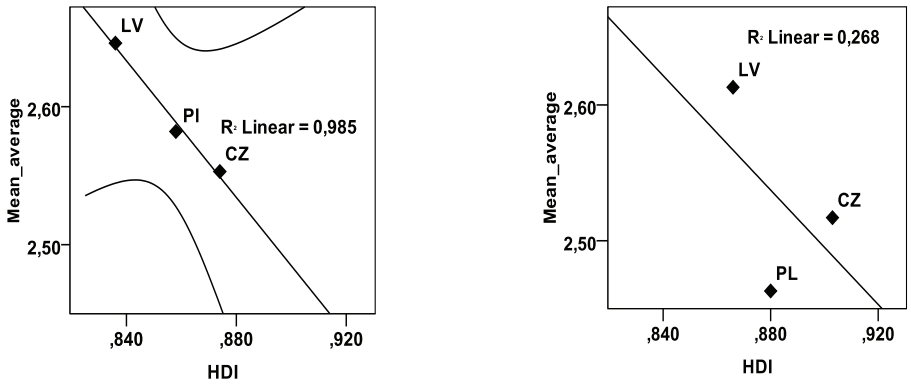


Figure 2. Dispersion graphs for three countries, Latvia (LV), Czech Republic (CZ) and Poland (PL) in 2003 (a) and 2008 (b).

On the other hand we must remember that the asset correlation (high coefficient of correlation) is only a number which do not explain realistic or exactly the background of correlation. It needs more investigations on this integrated and complicate field. F ex – are the number of countries, namely 11 in our investigation, enough to do such explanation. We can compare some R^2 values obtained by other researchers, who used HDI in their investigation connected

to bigger number of participating countries. C. Schreiner has calculated R for ACE average and HDI as -0.85 at $p < 0.01$ (Schreiner, 2006), which is at the same level as our calculation (-0,899, Table 4). Similar result is found by K.K. Stefánsson, who has been calculated R values for different items in parts B, F and G. He founded, that R values for B04, F14 and F16 are -0. 82, -0.95 resp. -0.92 (Stefánsson, 2006), which are, of course, higher as our results (-0.766, -0.660 resp. -0.674; table 2), but it seems that our results are good enough for qualitative analysis of data in such inquiries.

As it was pointed above, in three countries (Latvia, Czech Republic and Poland) the ROSE project has been repeated once more autumn 2007/ early 2008. Some results (Table 3) confirm that in general there do not are significant differences between 2003 and 2008 for those countries. The mean values ($1 \leq M \leq 4$) for students' interest in particular science topics, grouped according respective science subject (Chemistry, Biology, and Physics) had decreased in all three countries, except for Chemistry in Latvia and the Czech Republic. However, the level of interest in Chemistry was as low as 2.5, which meant that most of the students surveyed were not interested in Chemistry topics. It was demonstrated that there was no significant statistical difference between students' interest in science topics found in the studies from 2008 and 2003, with the exception of the interest in Biology in Poland ($t = 2{,}855$; $p = 0{,}004$, $\alpha = 0{,}95$). On the other hand, there are some significant differences in several statements such as D06 for all three countries, as well as in some other statements in single countries (H24: highly decreased in Czech Republic, but increased significantly in Poland).

Figure 2 confirms, that there are significant differences between R^2 values obtained in 2003 and 2008, namely, R^2 (2003) = 0,985 and R^2 (2008) = 0,268. It is a big difference, although the central trend is equal in both years: for higher HDI value corresponds lower average mean value through A, B and C Items in ROSE questionnaire, although the values, calculated for Czech and Polish students in 2008 partly do not confirm it. Probable the reason for this observation (Fig. 2) must be partly explained as result of an inadequate number of respondents participated in pilot project 2008 (about 140 respondents in both countries). But it is possible that there are some other factors, which affect our measurement and which do not are established now. Without fail the dispersion of the average mean value for all three countries in 2008 compared with ones in 2003 seems too big for simple explanation.

Conclusions

The indicators we have used in our analysis are widely used to determine countries' economic development can be successfully applied in the sphere of natural and environmental sciences. Therefore, it is interesting to look national level correlations between the indexes and some ROSE interest items.

Environmental Sustainability Index (ESI) displays a poorer correlation with the ROSE project results than Human Development Index (HDI) and Gross Domestic Product (GDP) per Capita. The ROSE project results in section D (*Me and the environmental challenges*) correlate well with GDP per capita. This would, probably, allow analysing indicators of different regions within one country, provided GDP for those regions is known.

Since the new index, Environmental Performance Index (EPI), which partly substitutes Environmental Sustainability Index (ESI), has been launched, the use of ESI as indicator for researches in science didactics is not anymore topical. The usefulness of EPI must be investigated separately, although it seems that the complexity of EPI (about 25 sub-indicators) do not will allow simply use it as a practical tool in science didactics research.

As even a high correlative coefficient does not fully explain the causal relationship, it is necessary to continue researching the impact of various economic, social and other factors on the formation of students' attitude to environmental and natural sciences. The investigat-

ed amount of countries seems good enough for qualitative correlation analysis from inquiries data.

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Appendix

Items	EXPLANATION
B04	Working in the area of environmental protection
D06	I can personally influence what happens with the environment
D10	People should care more about protection of the environment
D11	It is the responsibility of the rich countries to solve the environmental problems of the world
D12	I think each of us can make a significant contribution to environmental protection
D17	Nearly all human activity is damaging for the environment
D18	The natural world is sacred and should be left in peace
E03	The ozone layer and how it may be changed by humans
E04	The greenhouse efeect and how it may be changed by humans
E05	What can be done to ensure clean air and safe drinking water
E06	How technology helps us to handle waste, garbage and sewage
F14	I would like to become a scientist
F16	I would like to get a job in technology
H24	(I have) sorted garbage for recycling or for appropriate disposal

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